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SMALL SATS LIFECYCLE MANAGEMENT THROUGH MBSE AIDED DECISION MAKING TAILORED TOOL

Abstract

Traditional System Engineering approaches highlight some bottlenecks whenever dealing with information exchange among stakeholders, typically producing a large number of documents, difficult to trace and to keep harmonized. This is particularly true for space applications, which entail very complex systems conceivement, design, implementation and operation by a number of different players who grow with mission complexity. Model-Based System Engineering (MBSE) is intended to facilitate these activities, providing a common source of truth to the system engineering "ecosystem", improving its efficiency and quality by applying a model that evolves along the entire product lifecycle. The paper proposes a critical analysis of MBSE, demonstrating its potential and its gaps whenever exploited for small satellite missions design. The adopted approach goes through all System Engineering phases, from the high-level mission objectives definition, through the articulated internal and external functional analysis, down to system requirements generation and their role in driving the logical and physical trade-off analyzes, ending up with the AIV/AIT plans definition for all the subsystems; every modelling step is harmonized with proper conceptual operations description and consequent risk analysis. The study is conducted according to the Arcadia method and adopting the Capella tool, being very effective in mastering different engineering levels with coherence and with an iterative information refinement. Despite the clear advantage of having a unique model in which a change is inherently shared with all stakeholders, saving up time in communication, MBSE still lacks intelligent support that could strongly help in addressing the best optimal architecture in line with the system functionalities, speeding up the alternatives selection process. This would be particularly useful during the preliminary design phases, in which the almost infinite design choices are skimmed by the only system engineers knowledge, who may miss some solutions. A newly approach conceived to solve this issue is here described in the form of a decision-making tool prototype, that correlates a set of functionalities with a set of available technologies, proposing one or more architectures that are coherent with what the engineers expect from the system behaviour; a first grid of requirements is also part of the tool output, in support of the previously described MBSE approach. A number of applications will be shown, including a real small sat mission currently under ESA phase A study, demonstrating the tool effectiveness and its coupling with the Capella environment.